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E. I. TEREZ and G. A. TEREZ: The connection between solar activity and long-term trends of total ozone in the Northern hemisphere 1849

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R. P. LOWE, L. M. LEBLANC and K. L. GILBERT: WINDII/UARS observations of twilight behaviour of the hydroxyl airglow, at mid-latitude equinox 1863

F. SIGERNES: Estimation of initial auroral proton energy fluxes from Doppler profiles 1871

M. AYUKAWA, K. MAKITA, H. YAMAGISHI, M. EJIRI and T. SAKANOI: Characteristics of polar cap aurora 1885

S. N. ZAITSEV, G. P. MILINEVSKY and A. M. EVTUSHEVSKY: Simulation of the initial evolution of the CRRES G-9 barium release in the ionosphere 1895

R. L. COLLINS, X. TAO and C. S. GARDNER: Gravity wave activity in the upper mesosphere over Urbana, Illinois: lidar observations and analysis of gravity wave propagation models 1905

Y. SAHAI, D. H. GIERS, L. L. COGGER, P. R. FAGUNDES and G. P. GARBE: Solar flux and seasonal variations of the mesopause temperatures at 51°N 1927

S. M. L. MELO, H. TAKAHASHI, B. R. CLEMESHA, P. P. BATISTA and D. M. SIMONICH: Atomic oxygen concentrations from rocket airglow observations in the equatorial region 1935

H. TAKAHASHI, B. R. CLEMESHA, D. M. SIMONICH, S. M. L. MELO, N. R. TEIXEIRA, A. ERAS, J. STEGMAN and G. WITT: Rocket measurements of the equatorial airglow: MULTIFOT 92 database 1943

P. R. FAGUNDES, Y. SAHAI, H. TAKAHASHI, D. GOBBI and J. A. BITTENCOURT: Thermospheric and mesospheric temperatures during geomagnetic storms at 23°S 1963

J. L. INNIS, P. A. GREET and P. L. DYSON: Fabry–Perot spectrometer observations of the auroral oval/polar cap boundary above Mawson, Antarctica 1973

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